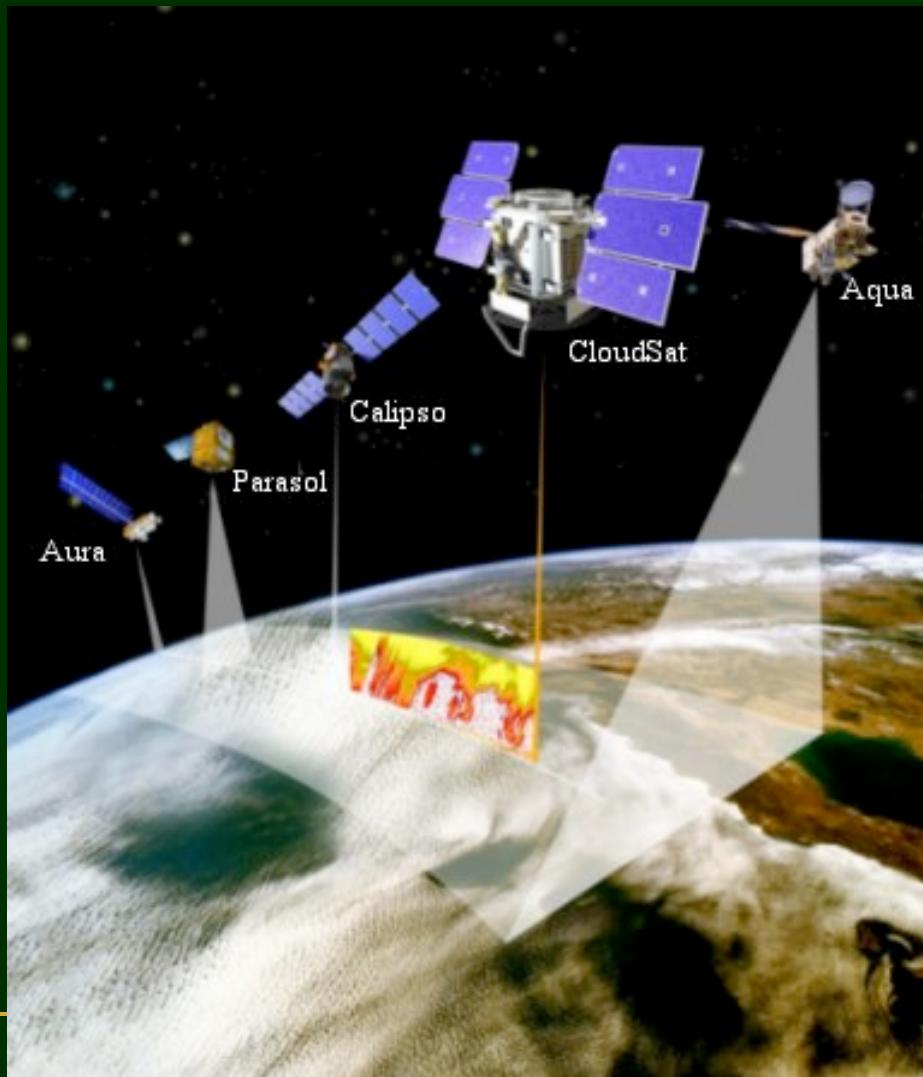


# Overview of CloudSat 2B Geometric Profile Products: 2B GeoProf and 2B GeoProf Lidar



Roger Marchand, U. Washington  
Gerald Mace, U. Utah

Wavelength 94 GHz

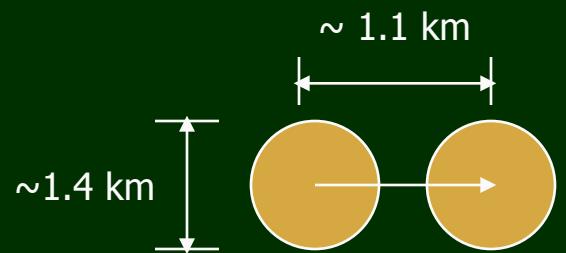
Sensitivity  $\sim -30$  dBZe

Vertical Resolution 480 m

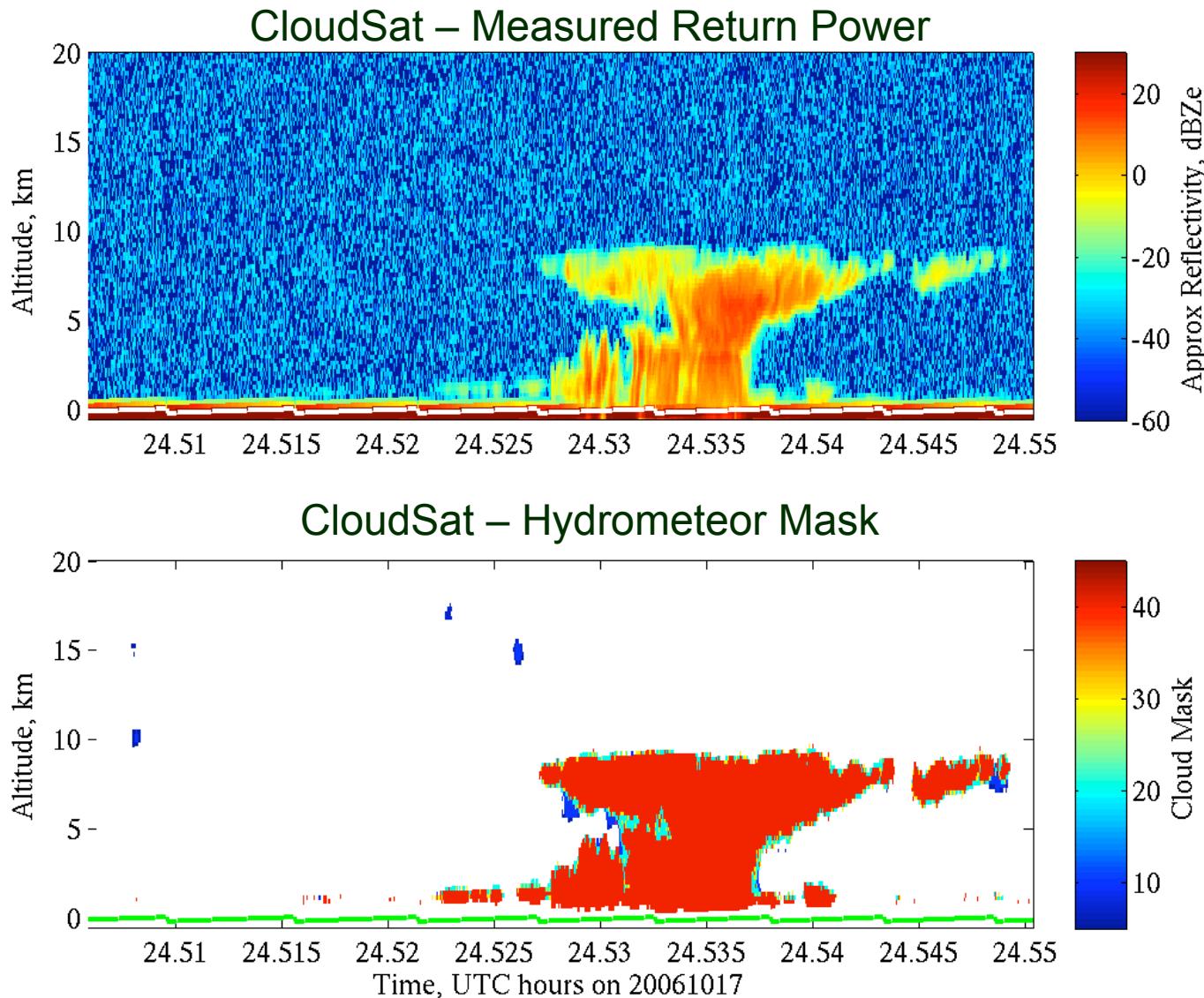
Vertical Sampling 240 m

Cross-track Resolution 1.4 km

Along-track Resolution 1.8 km  
(6 dB Footprint)



## 2B-GeoProf: Example of Calibrated Power & Mask



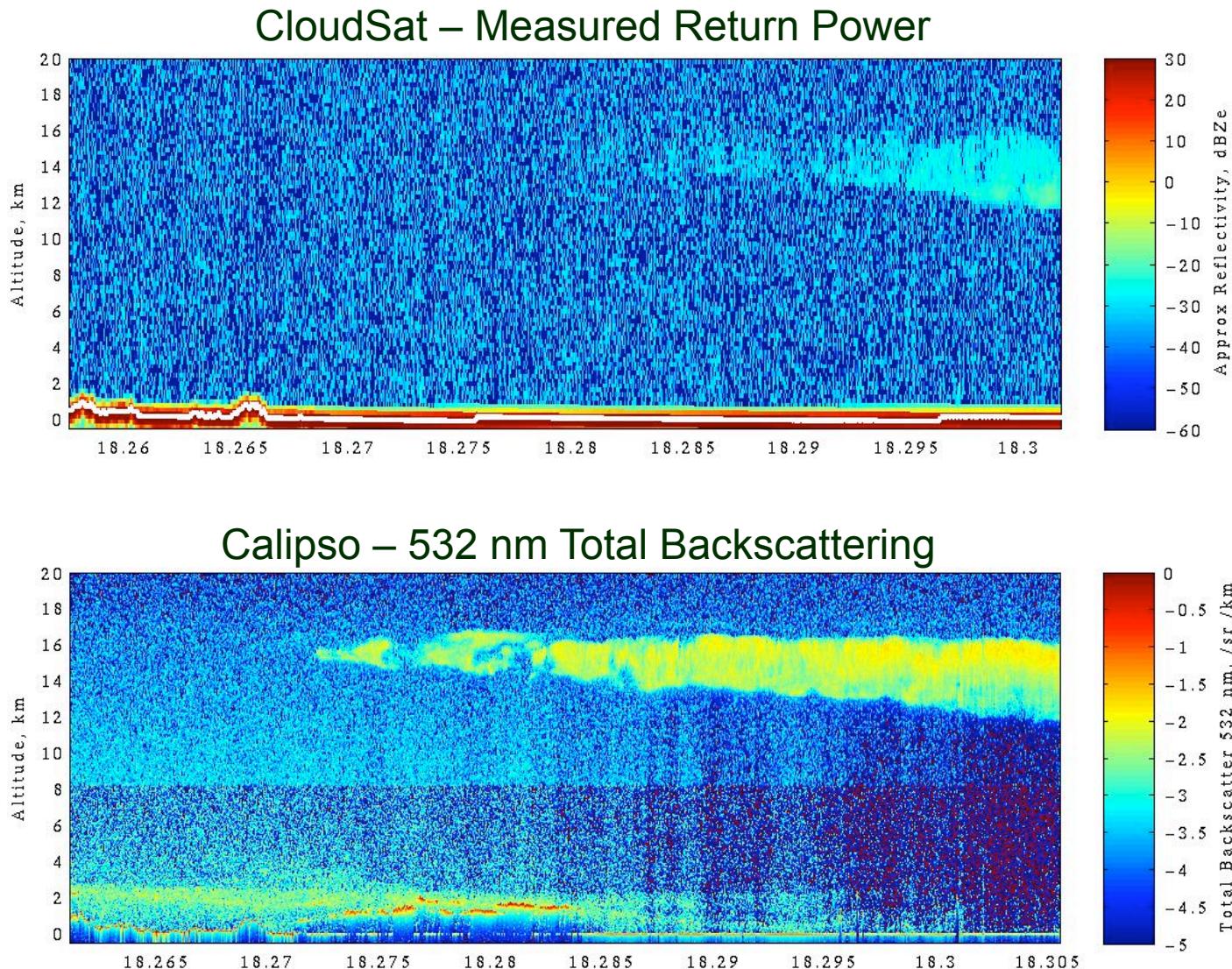
## 2B-GEOPROF product :

- Identifies where the return power is significant rather than noise or clutter.
- Cloud (or Hydrometeor) Mask values :
  - -9 = Bad or Missing radar data
  - 5 = significant echo but likely surface clutter/noise
  - 6-10 = weak echo (along track averaging), less than 50% likely to be false detection
  - 20 = weak echo (found without along track averaging), false detection<17%
  - 30 = good echo, false detection < 2%
  - 40 = strong echo, false detection < 0.2%
- In addition to the cloud mask, this product contains
  - The radar reflectivity (i.e., the calibrated measured return power )
  - An estimate of gaseous absorption loss of the observed reflectivity
  - “SurfaceHeightBin” = bin number IN THIS HEIGHT grid where surface is located
  - MODIS Cloud Flag, MODIS (250 m) Cloud Fraction, MODIS scene type and scene type variability
  - Estimates of Noise power
  - Land-Sea flag

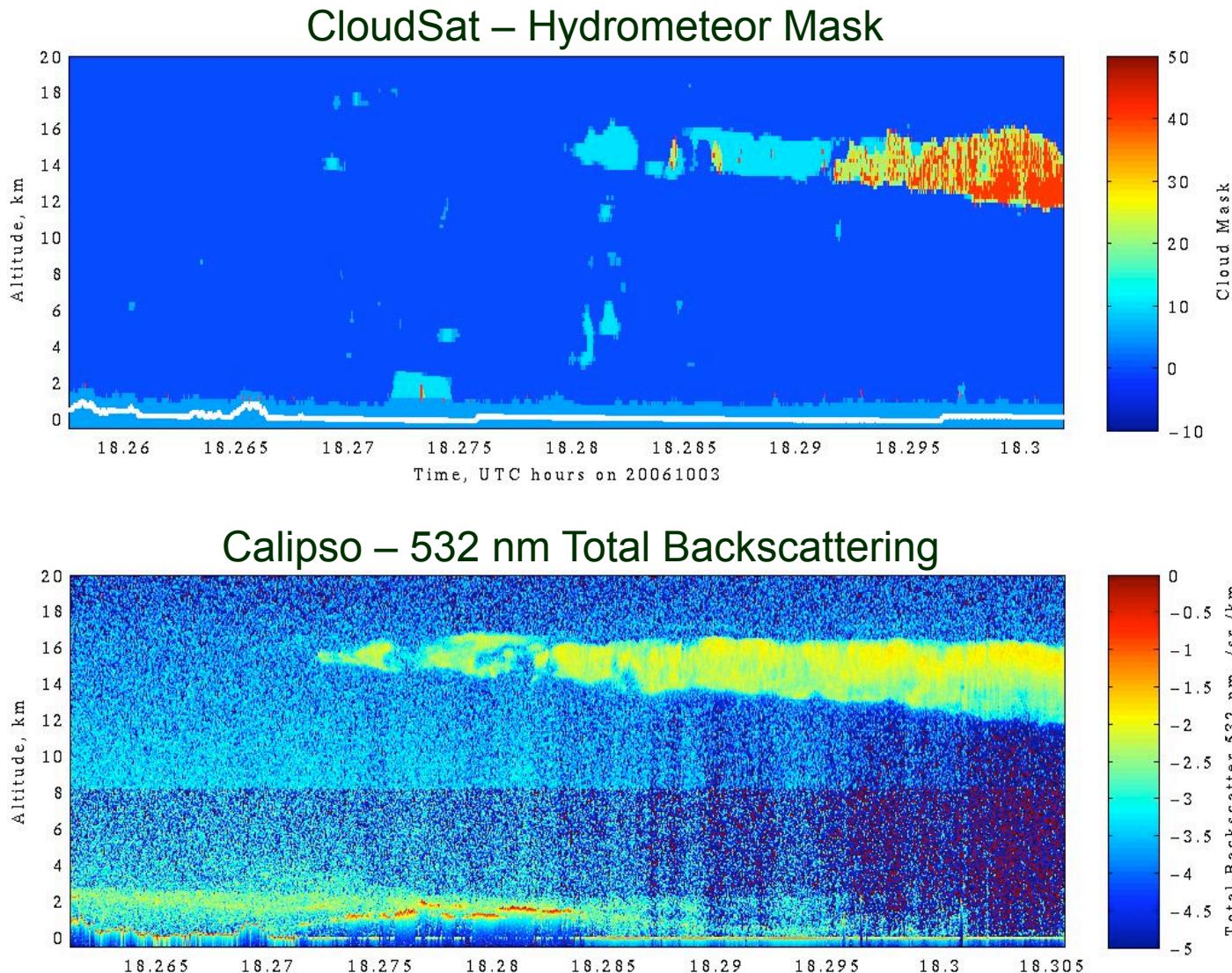
### **Detailed description of algorithm has been published -**

Marchand, R., G.G. Mace, T. Ackerman, and G. Stephens, 2008: Hydrometeor Detection Using Cloudsat - An Earth-Orbiting 94-GHz Cloud Radar. *J. Atmos. Oceanic Technol.*, 25, 519–533.

## Example of “thin” cirrus



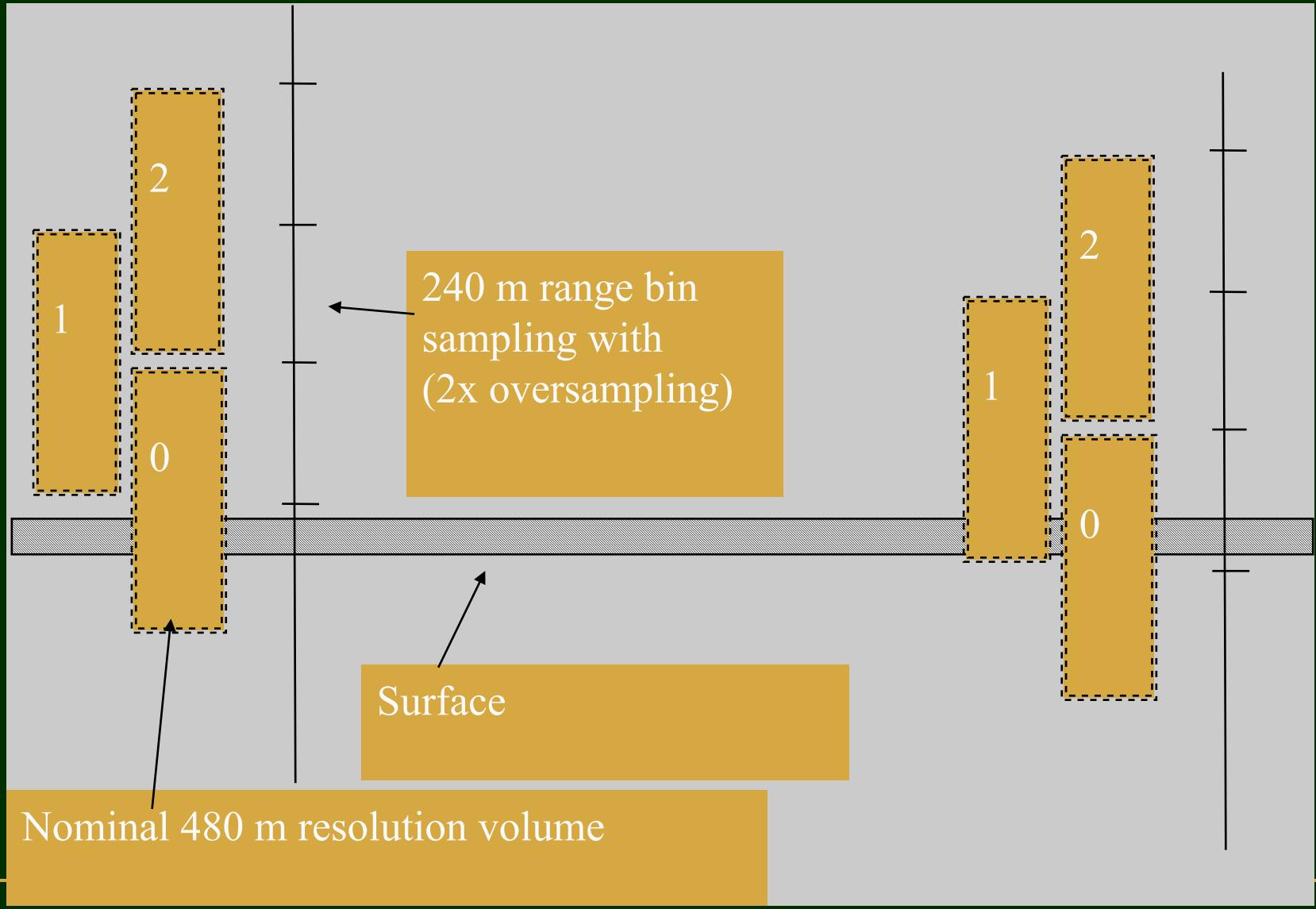
## Example of “thin” cirrus



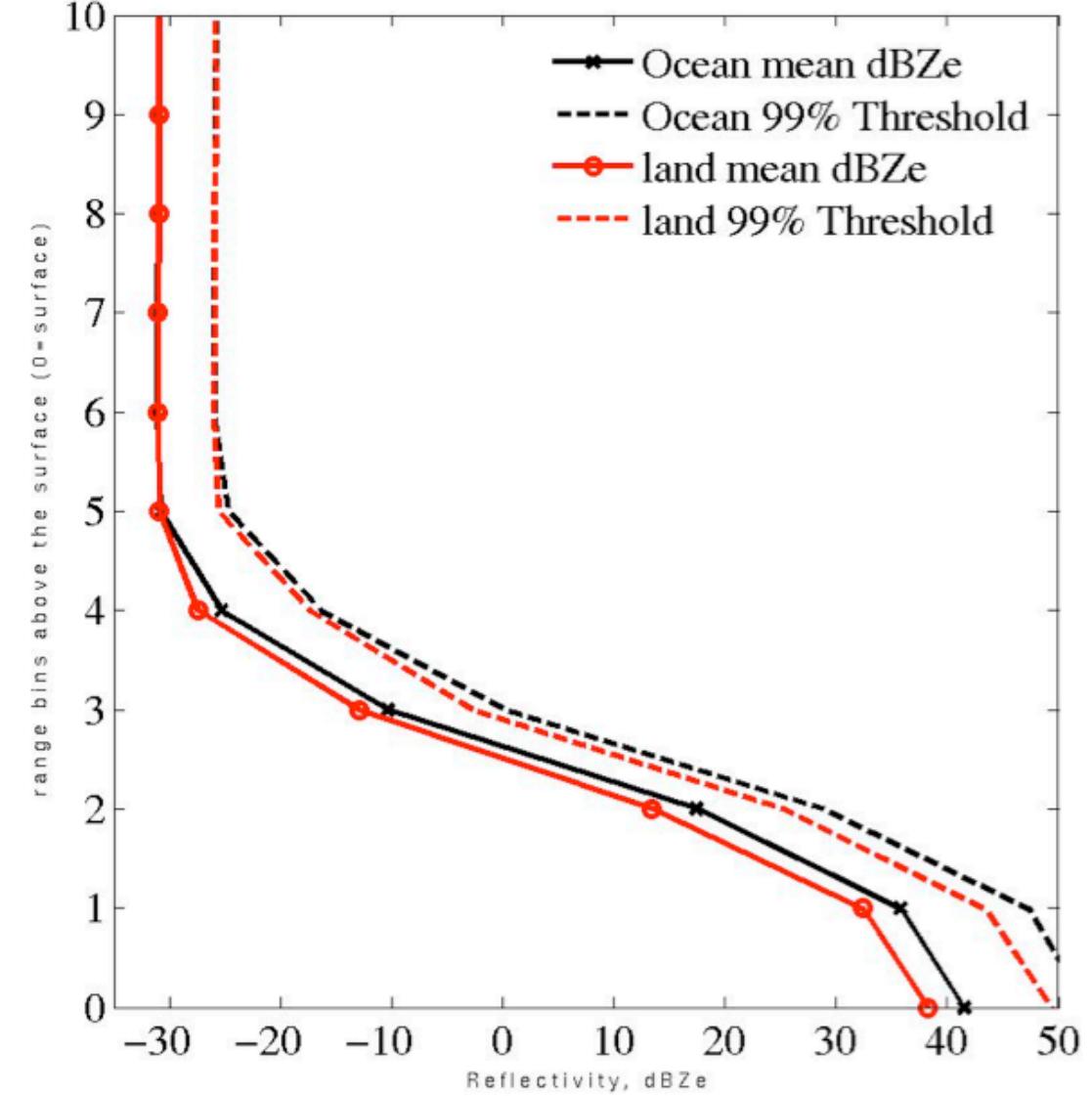
# False Detection Rate

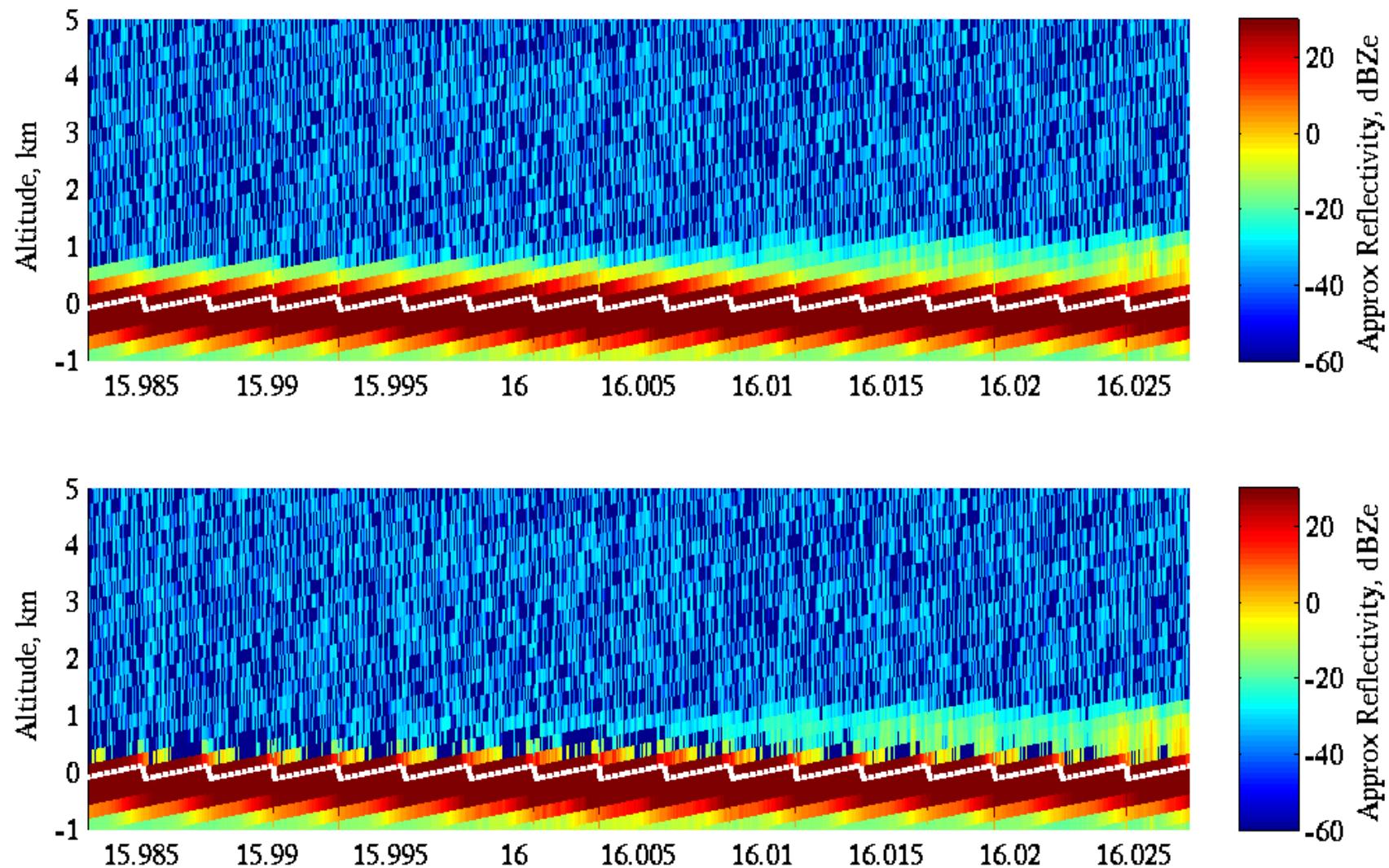
Mask Value	Meaning	% False Detections Goal	Estimated % False Detection via CALIPSO comparison
-9	Bad or missing radar data		
5	Significant return power but likely surface clutter		
6-10	Very weak echo (detected using along-track averaging)	< 50 %	44 %
20	Weak echo (detection may be artifact of spatial correlation)	< 16%	5 %
30	Good echo	< 2 %	4.3 %
40	Strong echo	< 0.2 %	0.6 %

# Oversampling



# Surface Clutter





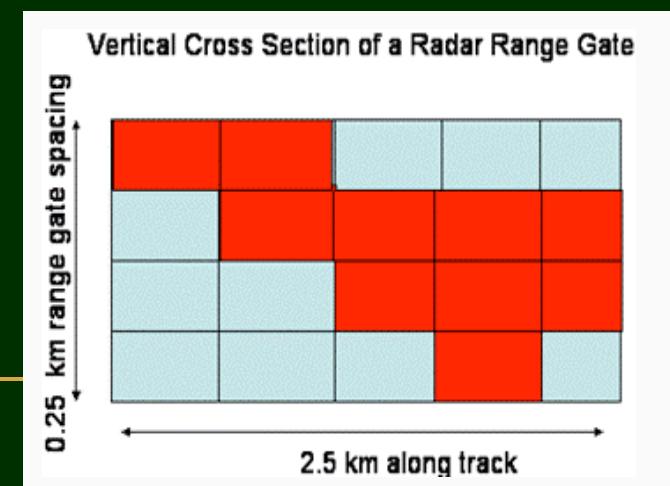
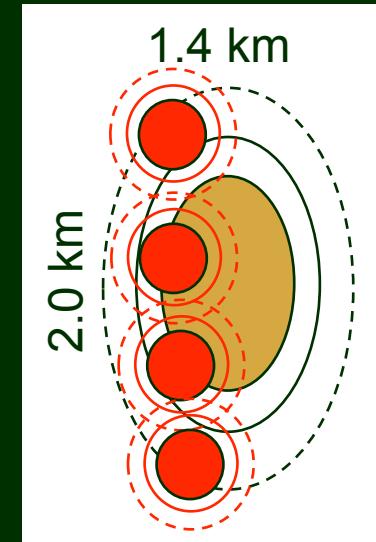
Ex. of surface clutter correction (Simone Tanelli, NASA JPL)

## 2B Geoprof-Lidar Product

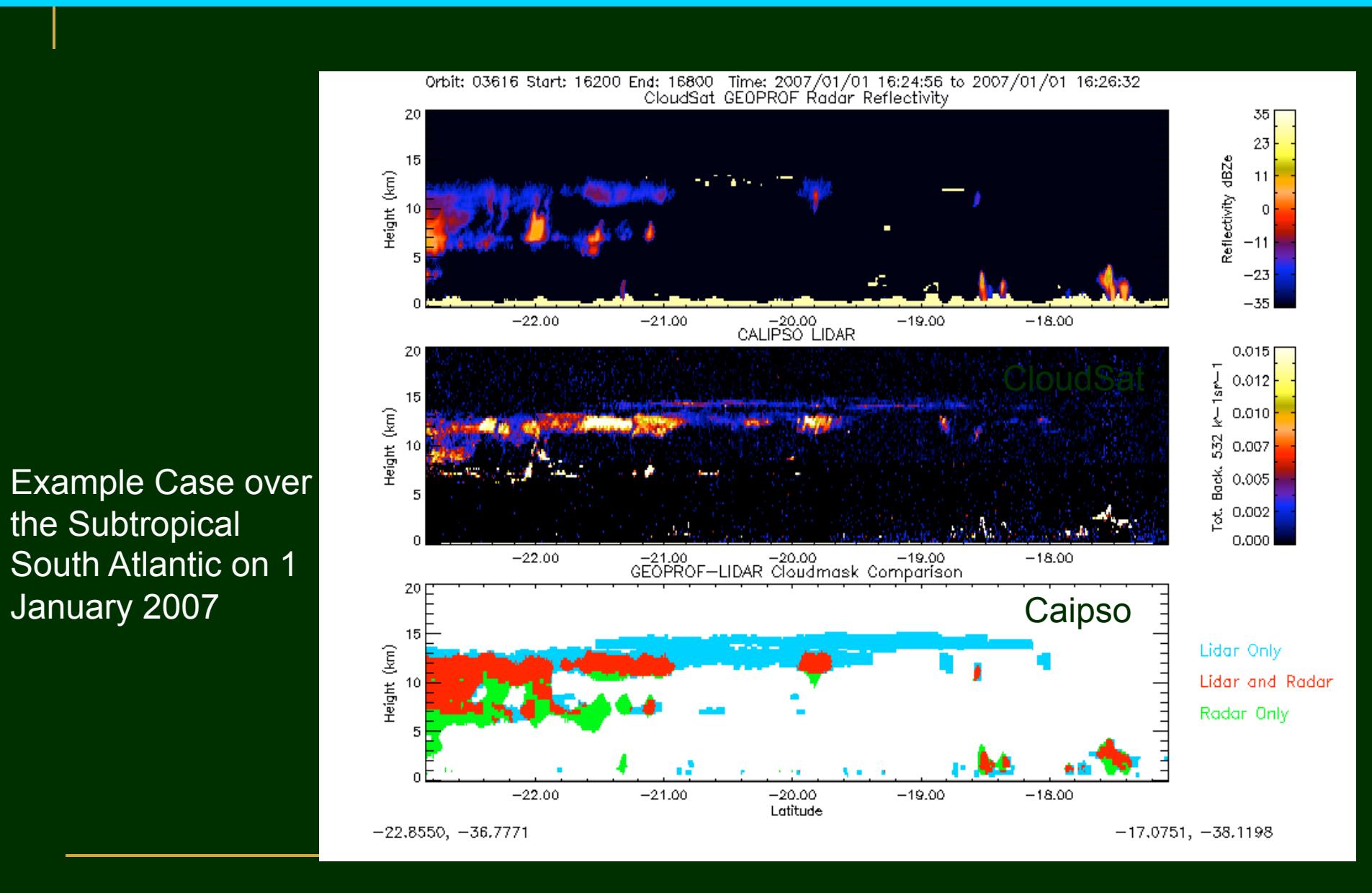
- Output referenced to Cloudsat footprint as specified in the 2B Geoprof product.
- Approach is to gather the lidar footprints that occur within or near the cloudsat footprint.

### Output of 2B-Geoprof-Lidar Product

- Cloud Fraction
- Cloud Layers
- Layer Base, Layer Top
- Layer Base Flag, Layer Top Flag
- 1064 nm attenuated backscatter,
- 532 nm total attenuated backscatter
- 532 nm perpendicular attenuated backscatter
- 532 nm extinction coefficient.
- 532 nm total attenuated backscatter (high vertical resolution).



## 2B Geoprof-Lidar Product

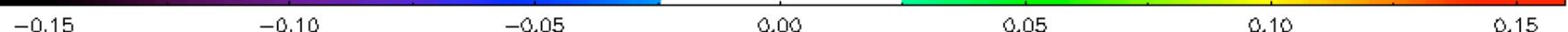
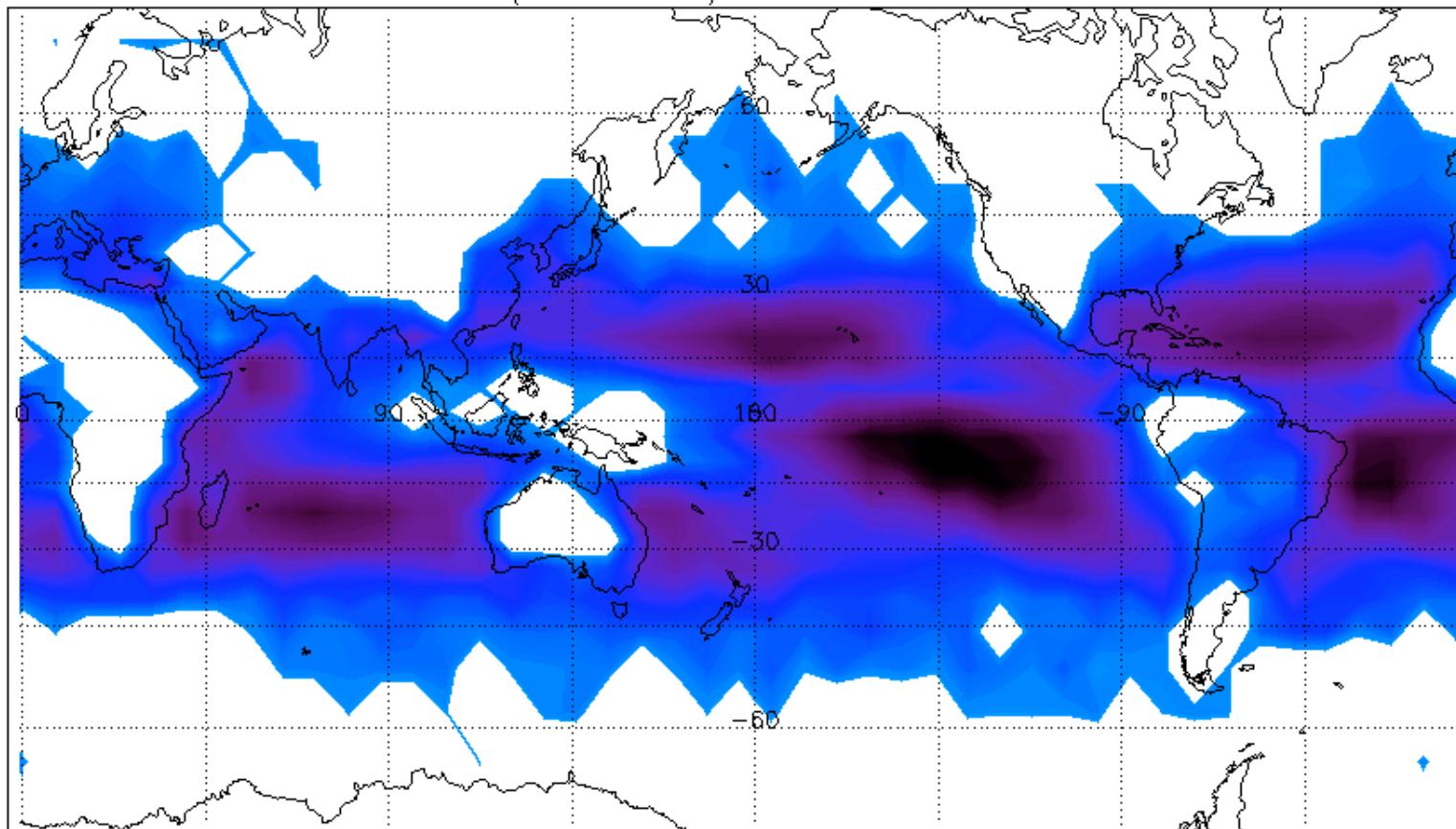


Changes to low clouds – Tops < 3 km, Layer Thickness < 3 km  
Period: August 2006 – February 2009

Highest Tops: 3000–0 Thickness: 0–3000 Avg Box: 6.0X8.0. For Period 200608–200902

Difference ("new" – "old")

white: -2.5% to 2.5%



## Upcoming changes ...

- 2B Geoprof

- Only minors changes for upcoming R05
- Improved/smoothed estimates of noise floor power & re-optimized filter parameters for weak detections (flag values 6 to 10) should result in few false detections (goal is 20% ... to be evaluated).
- Added estimate of minimum detectable signal.

- 2B Geoprof-lidar

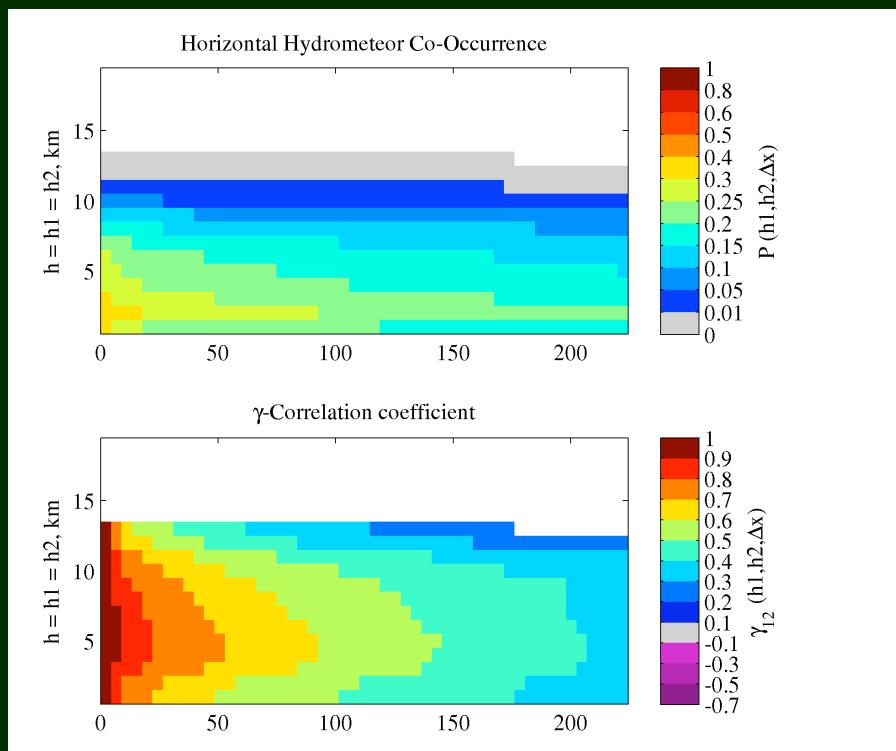
- Additional lidar variables
- Reprocessing R04 with updated VFM (available now!)
- Evaluating alternative lidar mask (Zhien Wang)

# Poster:

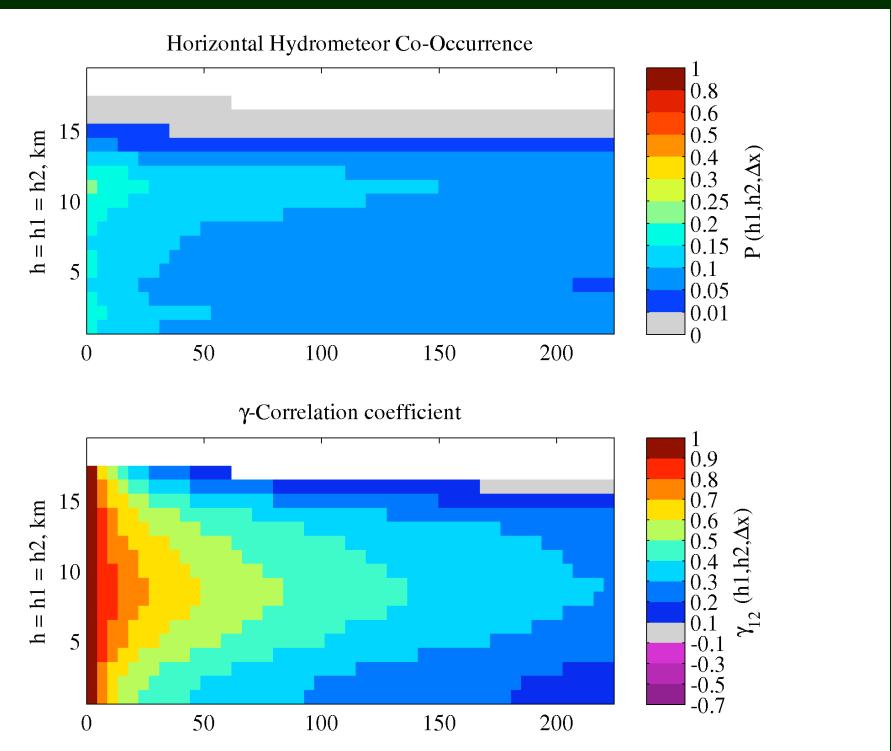
## Spatial Correlation in Hydrometeor Occurrence and Rain Rates ...

Examples of Co-Occurrence Correlation in the HORIZONTAL

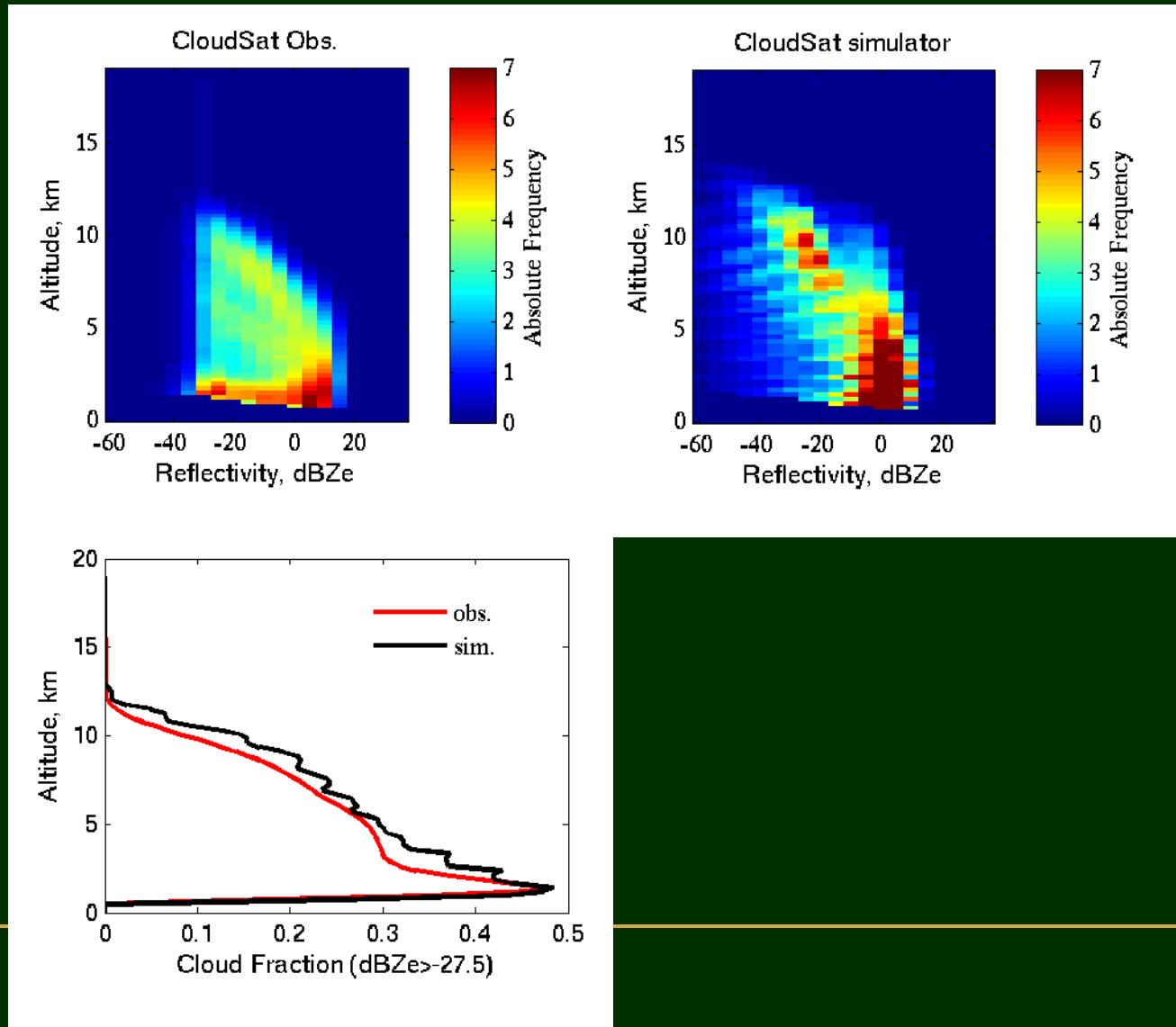
Latitude  $40^{\circ} - 50^{\circ}$  N



Latitude  $0^{\circ} - 10^{\circ}$  N

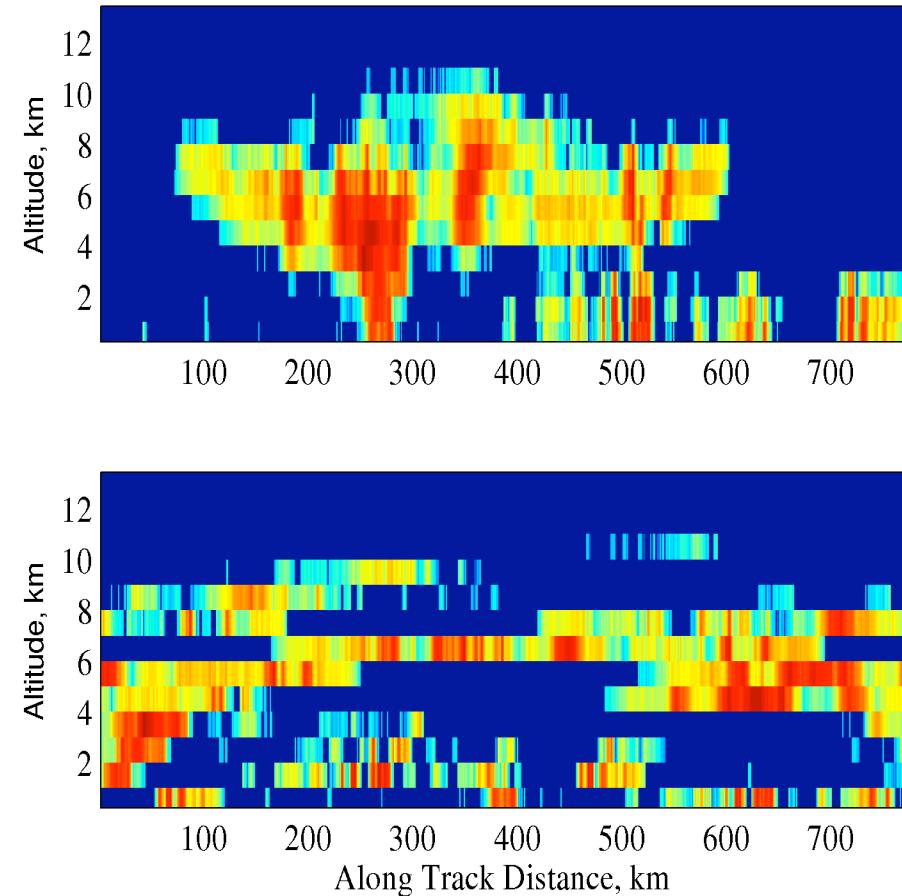


# Joint Histograms of Reflectivity vs. Height North Pacific - January

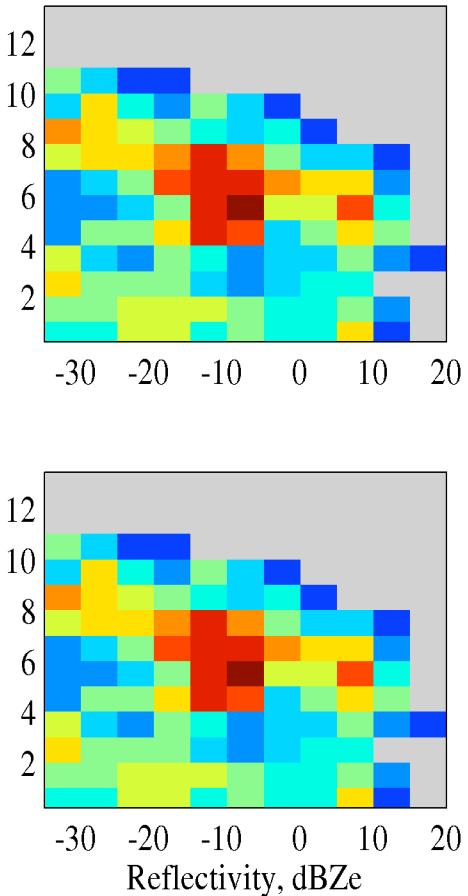


# Example of 1-point statistics...

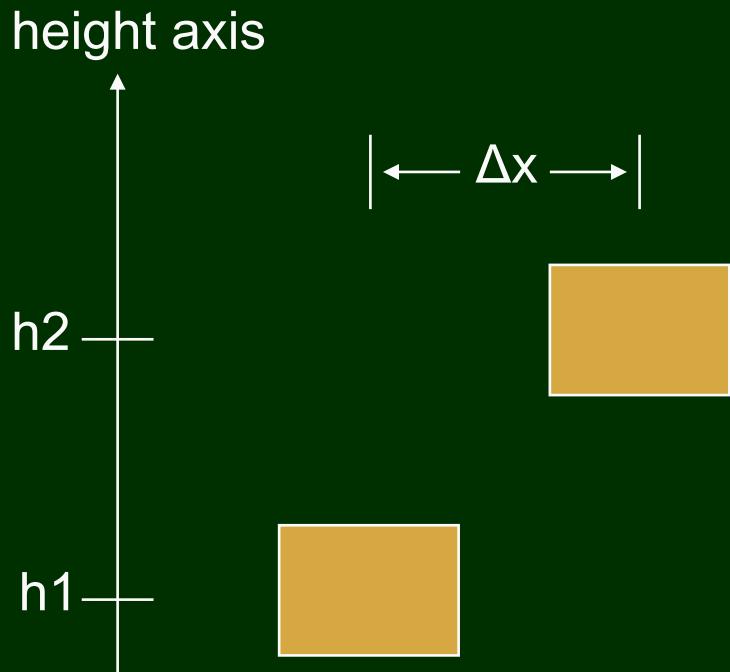
Typical CloudSat Scene  
(~1 km vertical res.)



Joint Histogram of  
Reflectivity with Height



# Geometry

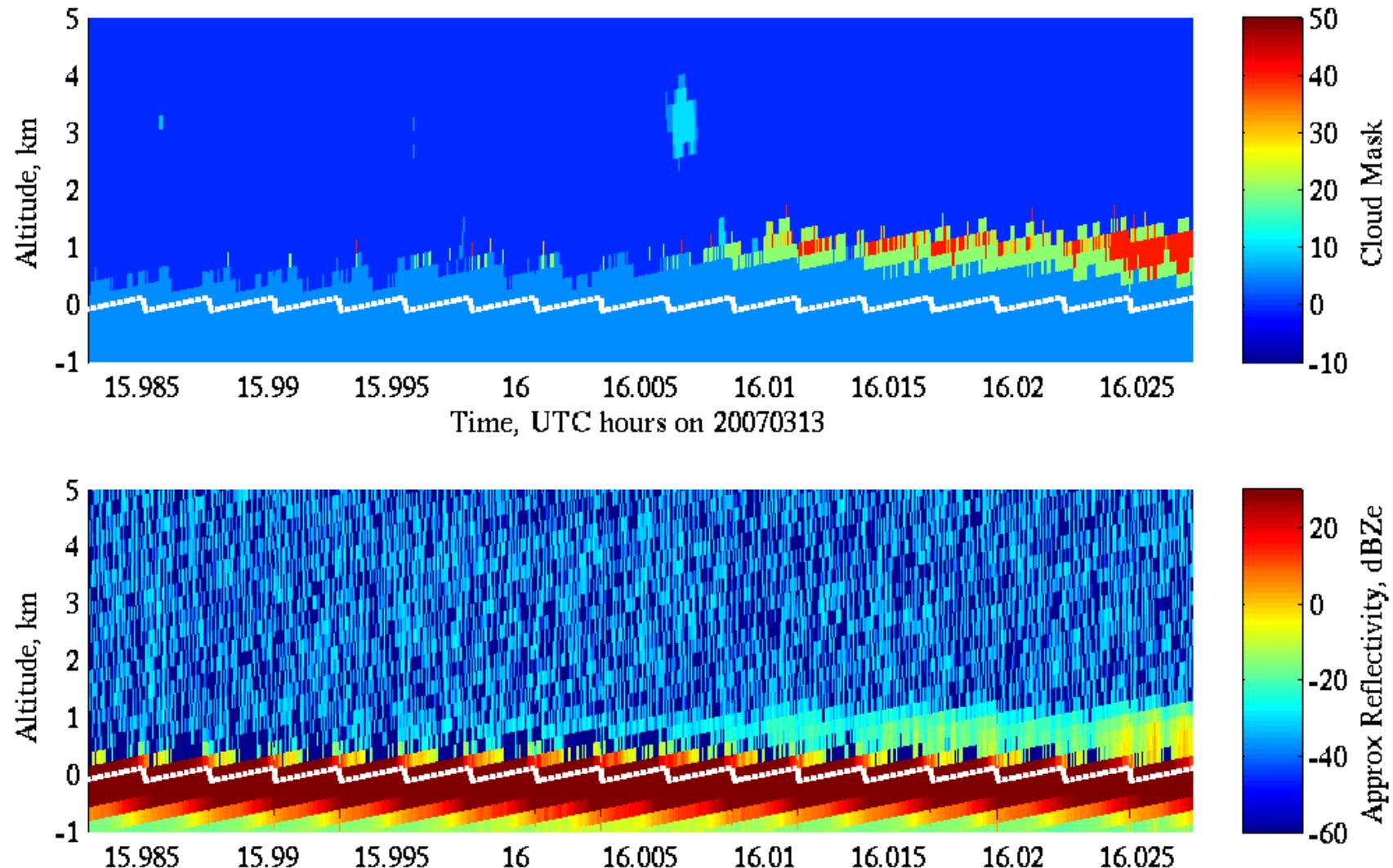


Probability of hydrometeor at some altitude  $h_1$  and  $h_2$  offset by  $\Delta x$ ,

$$P_{12}(h_1, h_2, \Delta x)$$

Joint probability density function (PDF) of dBZe at point  $(h_1, x)$  and dBZe at point  $(h_2, x + \Delta x)$

$$\text{pdf}_{\text{dBZe}_1, \text{dBZe}_2}(h_1, h_2, \Delta x)$$



Ex. of surface clutter correction (Simone Tanelli, NASA JPL)